To Investigate the Knowledge and Perceptions about AI and ML in Various Disciplines of Dentistry

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ABSTRACT
Introduction: The rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML) has significantly impacted healthcare, including dentistry. This study investigates the knowledge and perceptions about AI and ML in various disciplines of dentistry.
Methods: A self-structured questionnaire with 23 items was developed and distributed to dental practitioners, academicians, and researchers. The questionnaire assessed socio- demographic variables, knowledge, general perceptions, and specific perceptions regarding AI and ML.
Results: The study included 130 participants, predominantly young professionals aged 25-35 (55%) from urban areas (81%), with a majority being female (69%). (72%) of respondents felt knowledgeable about AI and ML, and 95% had positive general perceptions. Significant associations were found between location and designation with various domains of AI and ML applications. While 83% of participants agreed on AI and ML's benefits in diagnostics and 84% in treatment planning, opinions on risk assessment (47%) and prognosis (45%) were more varied**.**
Discussion: The findings align with existing literature, indicating a positive trend in the acceptance of AI and ML in dentistry. However, mixed opinions on risk assessment and prognosis highlight areas needing further research and validation. Structured AI training in dental curricula is recommended to enhance understanding and application.
Conclusion: Dental professionals generally have positive perceptions of AI and ML, particularly in diagnostics and treatment planning. Addressing gaps through education and research will enable better utilization of AI and ML, improving patient care and clinical outcomes.

1. Introduction

Artificial Intelligence (AI) and Machine Learning (ML) have rapidly advanced in recent years. AI refers to technologies that enable computers and other devices to replicate human-like intelligence and problem-solving skills (1). Machine Learning, a subset of AI, involves creating algorithms that allow computers to learn from data and make predictions or decisions based on that information (2). The development of AI began in the early 1950s, and it took nearly fifty years to evolve into a tool that is now widely used across various industries (3).

In healthcare, AI is becoming increasingly valuable as it aids doctors in delivering high-quality care and simplifies complex procedures by generating reliable predictions. Its applications are expanding quickly, reshaping the healthcare sector. Dentistry is also starting to benefit from these advancements. AI is emerging as a promising tool in this field, helping to reduce clinician workloads and simplify complex interpretations. However, AI also has its challenges. At times, it might lead to misinterpretations, so it's essential for practitioners to confirm the accuracy of these interpretations (4–6).

These technological innovations in dentistry have the potential to improve predictive results, expedite treatment planning, and increase diagnostic accuracy. The effective integration of AI and ML into dental practice largely depends on the understanding and perspective of dental clinicians (7). The use of these technologies varies globally, influenced by practitioners' familiarity with them and their accessibility.

Despite the incredible progress AI and ML have made in enhancing patient care, many dentists still find it challenging to fully grasp and utilize these technologies effectively. Recent studies have explored the knowledge, perceptions, applications, and challenges of AI and ML in dentistry worldwide. These studies generally indicate a promising outlook for the usefulness of these technologies (9). However, the adaptation of AI and ML often depends on practitioners' exposure to these tools in patient care or through professional reviews.

While many studies highlight the potential benefits of AI and ML in dentistry, they also identify several challenges related to their implementation (10–13). Effective Machine Learning (ML) applications require managing large data sets to ensure accurate predictions. Improper handling of algorithms, however, can lead to risks of data misinterpretation.

This study aims to investigate the knowledge and perceptions of AI and ML across various dental disciplines. Previous researches had predominantly focused on specific applications of AI and ML, such as lesion detection, cancer diagnosis, and the interpretation of radiographic images (4,10,14,15). In contrast, this study, however, seeks to provide a more comprehensive analysis by examining how AI and ML are perceived and understood in broader contexts, including risk assessment, diagnostic processes, treatment planning, and prognosis in dentistry.

2. Methods

A self-structured questionnaire was developed and circulated via Google Forms to investigate the knowledge and perceptions about AI and ML in various disciplines of dentistry. The study included participants who were working in the various fields of dentistry and who gave consent to participate in the study. The questionnaire contains 23 items, and later it was categorized into different domains namely Socio-demographic variables of the participants, Knowledge, General perceptions, and perceptions about risk assessment, diagnosis, treatment plan, and prognosis

Tools

The categorization of the domains was done in MS Excel and various questions were compiled under each domain, listed in the below table.

Domains
a) Socio-demographic variables (age, gender, location, designation)
b) Knowledge about AI and ML: i) Know the term of AI and ML ii) Aware of the principles of AI and ML iii) AI and ML can expedite the diagnosis of oral diseases from the algorithms of AI and ML
c) General perception about AI and ML: i) whether it can manage documents ii) can be used in research iii) Speed up the treatment protocols iv) Interpretations can be used

d) Perception of risk assessment of AI and ML and whether it can be performed for individuals.
e) Perception of diagnosis i) It can be used to interpret intraoral radiographic images ii) It can diagnose lesions and cancer using photomicrographs iii) It can diagnose cancer periodontal diseases
f) Perception of the treatment plan i) It can be used in guided implant surgeries ii) It can formulate a comprehensive treatment plan iii) It can be used in CAD/CAM technology
g) Perception of the prognosis of AI and ML and whether it can predict for individuals.

It was a 5-point Likert-type rating scale from strongly disagree to strongly. According to Hussain Alkharusi, the interpretation of the Likert scale was described by finding the range of composite scores representing the means and then constructing the class intervals by adding the width to the lower limit of the first-class interval, which is the minimum composite score. Thus it have equality between the numbers in the response intervals (16).

Ethical considerations

Ethical approval was obtained from the IEC.

3. Data Analysis

The responses were entered into an MS Excel spreadsheet followed by analysis using a trial version of SPSS. The test of normality was analyzed for the various domains to check the normality of the data. The demographic variables and the proportion of the respondents under each domain were represented using frequency and percentage. Mean ±SD, and median (IQR) were represented for the scores under each domain. The association between demographic variables and domains among the respondents was assessed using a chi-square/ Fisher's Exact test. A p-value < 0.05 is considered statistically significant.

4. Results

Table 1: Distribution of respondents according to their socio-demographic variables

Socio-demographic Variables	Frequency n (%)
Age	
25-35	72 (55%)
36-45	45 (35%)
46-55	9 (7%)
55-65	4 (3%)
Gender	
Male	40 (31%)
Female	90 (69%)

Socio-demographic Variables	Frequency n (%)
Location	
Rural	5 (4%)
Sub-urban	20 (15%)
Urban	105 (81%)
Designation	
Academician	34 (26%)
Practitioner	72 (55%)
Researcher	5 (4)
Academician/ Practitioner	10 (8%)
Academician/ Researcher	1 (1%)
Practitioner/ Researcher	1 (1%)
Academician/ Practitioner/ Researcher	7 (5%)

The survey results indicate that most respondents were young professionals aged 25-35 (55%), predominantly from urban areas (81%) and many of the participants were female (69%). Practitioners (55%) constitute the largest group, followed by academicians (26%). There is also a notable presence of individuals in combined roles.

Table 2: Proportion of the respondents under each domain

Proportion of the respondents under each domain					
Domains	Strongly Disagree n (%)	Disagree n (%)	Neither agree nor disagree n (%)	Agree n (%)	Strongly agree n (%)
Knowledge	-	2 (2%)	34 (26%)	47 (36%)	47 (36%)
Perception	-		6 (5%)	73 (56%)	51 (39%)
Risk assessment	1 (1%)	9 (7%)	34 (26%)	61 (47%)	25 (19%)
Diagnosis	-	3 (2%)	19 (15%)	72 (55%)	36 (28%)
Treatment plan	-	1 (1%)	19 (15%)	67 (51%)	43 (33%)
Prognosis	-	12 (9%)	39 (30%)	58 (45%)	21 (16%)

Most respondents (72%) feel knowledgeable about AI and ML, though a notable percentage (26%) were neutral, and a small fraction (2%) disagreed. General perceptions about AI and ML were very positive, with 95% of respondents agreeing and strongly agreeing. The remaining 5% were neutral, and no respondents disagreed. AI and ML can help with dental care diagnostics, according to a large

percentage of responders (55%) agreed and strongly agreed (28%). 7% were neutral, while only 1% disagreed. Regarding the use of AI and ML in treatment planning, most respondents (84%) agreed and strongly agreed, while 15% and 1% were neutral or disagree. Opinions on AI and ML's ability to perform risk assessments are mixed. While a majority (47%) agreed, a significant portion (26%) were neutral followed by 19% strongly agreed, and (7%) disagreed and strongly disagreed (1%). A smaller majority (45%) agreed with the prognosis projection, followed by 30% who were neutral, 16% who strongly agreed, and 7% who disagreed.

The findings show strong positive perceptions towards AI and ML in dentistry healthcare applications, especially in general perceptions, diagnosis, treatment planning, and knowledge. However, there was variation in opinions on specific capabilities such as risk assessment and prognosis prediction. This suggests that there are areas where respondents may be less confident or more cautious about the effectiveness of AI and ML.

Table 3: Scores under each domain

Scores under each domain				
Domains	Mean (SD)	Median (IQR)	Minimum	Maximum
Knowledge	11.7± 2.01	12 (10-13)	3	15
Perception	16.6± 2.12	16 (16-18)	4	20
Risk Assessment	3.7± 0.8	4 (3-4)	1	5
Diagnosis	23.7± 3.7	24 (21.7-26)	6	30
Treatment Plan	20.3± 3	20 (18-23)	5	25
Prognosis	3.6± 0.8	4 (3-4)	1	5

The above table shows the mean± SD scores obtained by the participants under each domain. Respectively, scores were knowledge (11.7± 2.01), perception (16.6± 2.12), risk Assessment (3.7± 0.8), diagnosis (23.7± 3.7), treatment Plan (20.3± 3), and prognosis (3.6± 0.8).

Table 4: Association between socio-demographic variables and knowledge/ perception regarding AI & ML in dentistry

Association between socio-demographic variables and knowledge/ perception regarding AI & ML in dentistry						
Domains	Knowledge	Perception	Risk Assessment	Diagnosis	Treatment Plan	Prognosis
Age	0.38*	0.3*	0.35*	0.68*	0.21*	0.8
Gender	0.05	0.1	0.35	0.37	0.07	0.49
Location	0.13*	**0.005***	0.05*	**0.03***	**0.01***	**0.03***
Designation	0.19*	**0.03***	**0.01***	0.49*	**0.005***	**0.03***

The above table shows the p-value and the study investigated the association between socio-demographic variables (age, gender, location, and designation) and various domains (knowledge, perception, risk assessment, diagnosis, treatment plan, and prognosis) regarding AI and ML in dentistry. The study found that there was a significant association between location with perception, diagnosis, treatment plan, prognosis, and designation with perception, risk assessment, treatment plan, and prognosis.

5. Discussion

In recent years the evolution of AI and ML has increased in various aspects of healthcare settings like diagnostics, treatment planning, risk assessment, and prognosis all over the world. This study assessed the current knowledge and perception of AI and ML in various aspects of dentistry. The respondents of this study were mostly practitioners from urban areas. It was found that there was a positive perception of diagnosis and treatment planning. And there was mixed opinion about the risk assessment and prognosis.

The present study found that 72% of respondents feel knowledgeable about AI and ML, and 95% have a positive general perception. Similarly, a recent study conducted in India reported that more than half of the respondents agreed that AI could improve healthcare settings and act as an assisting tool without replacing the practitioners. The study concluded that respondents were demanding structured AI training (17). In 2022 a survey conducted by Dr.Fernandes Shoba et.al among dental students concluded that respectively, 64% and 53% of the respondents had basic knowledge and a positive perception of AI in dentistry (18). Comparatively, a study conducted in India reported that 36% of respondents were not aware of AI and there was a lack of knowledge about deep learning models in dentistry. The study concluded with the suggestion of updating AI in the dental curriculum (19).

In our study, respondents agreed that AI and ML could assist with dental diagnostics (83%) and treatment planning (84%). Similarly, a recent study shows that ML methods have demonstrated significant potential in automating dental diagnosis and treatment planning, but the implementation of ML would have challenges like algorithm bias and data privacy (20)**.** Notably, a study was investigated for detecting oral cancer and lesions using machine learning and the results showed that ML was promising in early detection (12). A scoping review was

done for the studies published from 2015 to 2019 across different countries regarding the use of convolutional neural networks (CNN) for dental image diagnostics and the study concluded that CNN may be used to assist dentists comprehensively and may be useful in-patient care (21).

Systematic reviews were conducted to detect periodontitis, orthodontics diagnostics, and treatment planning and find the usage of CAD/CAM in using AI and ML. The reviews concluded that detecting periodontal and orthodontics diseases using AI shows the same result as experts. CAD/CAM using AI and ML can assist promising clinicians and minimize misinterpretations (11,14,22).

Opinions on risk assessment were mixed in this study, with 47% agreeing and 26% neutral. As for prognosis prediction, the present study found that 45% of respondents agreed, 30% were neutral, and 16% strongly agreed. This variation suggests that while there is a recognition of the potential for AI and ML in risk assessment and prognosis. A scoping review was conducted to evaluate the performance of AI in the prognosis of dental implants. Results showed that there was an accuracy of 70% to 96% for prognosis from the reviewed studies (23).

Notably, a study was conducted to establish an AI module for tooth prognosis. The researcher included three different ML methods used to create an algorithm and evaluated it against gold- standard data determined by experts. The results of the study show that out of three ML methods, one method showed 84% accuracy and the study concluded that AI would help determine the prognosis (24). Regarding risk assessment there were no related studies have been done.

However, a study reported that proper machine learning algorithms were useful for assessing and predicting the outcomes. The study concluded that it is reasonable to anticipate that a computer-aided detection system will develop into a reliable and efficient means of diagnosis and prediction (15).

The present study reveals that there was a significant association between location, designation, and various domains in dentistry. There were no related studies that checked for the associations between demographic variables and perceptions about AI and ML in dentistry.

The literature supports the positive perceptions towards AI and ML in diagnostic, and treatment planning applications observed in our study, reflecting a broader trend of acceptance and optimism. However, the mixed opinions on risk assessment and prognosis prediction underscore the need for further research and validation in these areas. This is crucial for addressing the uncertainties and enhancing the confidence of dental professionals in AI and ML technologies.

6. Recommendations

Including structured AI training in the curriculum helps the medical/ dental students to know the applications of AI, understand the benefits and challenges that would improve their knowledge, and gain a deeper understanding. It helps to utilize them effectively and efficiently. Further research would be helpful to update themselves to up to date.

7. Limitations

The generalizability of the findings would be ineffective due to the smaller number of respondents.

8. Conclusion

The findings from this study align with those from other research, reinforcing the overall positive perception of AI and ML among dental professionals. However, the variation in opinions on specific capabilities such as risk assessment and prognosis prediction highlights areas where more work is needed. By addressing these gaps through targeted education, training, and rigorous validation studies, the dental profession can fully harness the potential of AI and ML to improve patient care and clinical outcomes.

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